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Archeology of Ancient China

Recent research reveals recurrent themes of the ancient world and salient features that are uniquely Chinese.

Kwang-chih Chang

In the two tumultuous decades between 1945, when China began national reconstruction in the ruinous wake of the Eight-Year War of Resistance, and 1966, when the Red Guards began their efforts to force a whole nation to turn its back on the past, Chinese archeologists made phenomenal strides in uncovering the antecedent and formative stages of their civilization. To be sure, modern archeology was born in China as early as 1920—the year in which the first Paleolithic implements and the first Neolithic site were brought to light—when the inquiry into China's past was transformed from an antiquarian pursuit for gentleman-scholars into a dirt science of empirical evidence. By the start of the war in 1937, the world of archeology had become acquainted with Peking Man of the Middle Pleistocene—deer hunter, quartz knapper, probable cannibal, and world's earliest known user of fire; Ordos Man of the Late Pleistocene loess land—maker of sophisticated blade implements; the remains of the Upper Cave family of the latest Pleistocene, buried with red ochre and ornaments of bone, shell, and stone; the Yang-shao Culture of western north China, characterized by red pottery vessels painted with brown and black designs and thought to be an eastern offshoot of the Painted Pottery Culture of Western Asia; the Lung-shan Culture of the Pacific seaboard of eastern China, with walled villages, thin, lustrous, black pottery, and oracle bones; and, finally, the Shang civilization excavated from An-yang, in northern Honan, with its spectacular ritual bronzes, oracles' writing, horse-drawn chariot, chamber burial, human sacrifice, and other features that seemed to have blossomed on Chinese soil without apparent antecedent. These findings, important though they plainly are, were few and far between, and the prehistory and early history of the Old China they exemplified were disjoint and often enigmatic (*1*). Only after World War II did data begin to multiply and a fuller story to unfold. On the basis of the prewar knowledge, major advances in China's recent archeology of its ancient period may be described under the following headings (*2*).

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Science and Archeology

Geological and paleontological investigations of the Chinese Pleistocene had attained considerable maturity by the 1940's. Since then, new data has rapidly accumulated, and Pleistocene stratigraphy and its subdivisions have been significantly refined (*3–5*). The most outstanding new studies of the environment of the ancient peoples in China have, however, been in the area of palynology. Pollen profiles have been obtained at many localities from Taiwan in the south (*6*) to the Liaotung Peninsula in the north (*7*) from peat deposits and lake sediments of various ages within the Pleistocene and during the postglacial period. Their major contributions to prehistoric and early historic archeology in China fall within several areas. (i) Pollen analyses of sediments taken from geological deposits, attributable to all subdivisions of the Pleistocene, throughout the country show that these sediments were deposited under widely differing climatic conditions, and, furthermore, that cold vegetational assemblages are normally found in deposits believed to date from glacial intervals and thermophilic assemblages from interglacial intervals (*5*). In other words, the hypothetical correlation of Pleistocene subdivisions with the glacial sequence in the highlands according to geological and paleontological evidence has largely been confirmed by palynological studies. (ii) Analyses of pollen assemblages enable dating of paleolith-bearing and human fossiliferous localities and strata to broad climatic intervals within the Pleistocene and its subdivisions. A pollen profile at Locality 1 at Chou-k'ou-tien (Fig. 1), for instance, discloses a cold beginning and a cold end, with a long warm interval between; this confirms the dating of Peking Man and the Choukoutienian strata at this locality to the Second Glacial, the Second Interglacial, and the Third Glacial (*8*). (iii) A pollen profile taken from a peat at P'u-lan-tien in the Liaotung Peninsula and another taken from lake sediments at Jih-yüeh-t'an in central Formosa indicate a postglacial hypsithermal interval from about 8000 to 4000 years ago, an interval into which fit the crucial phases of cultural development from the preagricultural stage to the rise of the civilization (*6*, *7*). (iv) The vegetational history revealed by the core taken from Jih-yüeh-t'an further denotes patterns of forest growth and rejuvenation that are of great significance in the study of early agriculture

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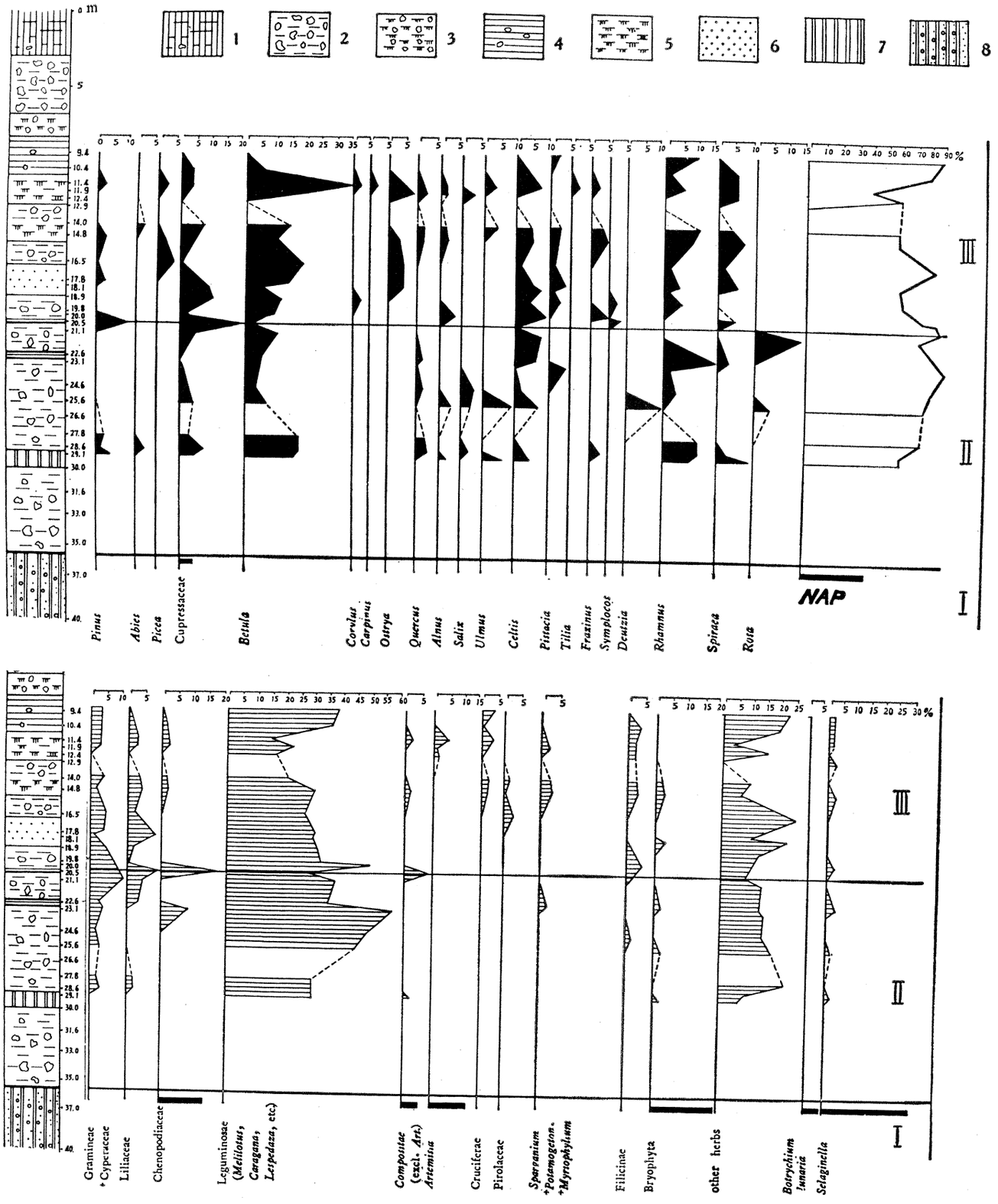

Fig. 1. Sporo-pollen diagram of the Locality 1 profile at Chou-k'ou-tien. *1*, Loam; *2*, breccia; *3*, sandy loam with pieces of limestone; *4*, loam with charcoal; *5*, calcareous tufa with sandy loam; *6*, sand; *7*, red sandy loam; *8*, red clay with sands and gravels. [Original figure, from (*8*), was continuous. Here it is broken up into two segments to facilitate reproduction.]

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(*6*), an aspect of research to be discussed further, below.

Scientific techniques for absolute dating have been used extremely rarely. One uranium-thorium date for Peking Man gives a range of 210,000 to 500,000+ years (*4*) and radiocarbon dates are not known except for two determinations from Kwangtung (*9*), a few dates obtained from iron objects in museums overseas (*10*), and a long series from Taiwan (*6, 11*). Those from Taiwan not only indicate the relative antiquity of prehistoric cultures but they also place the whole postglacial sedimentary and palynological events on a firm chronological scale that has proved extremely valuable for cultural prehistory of the southeast as a whole. Other than in the above, as well as in the occasional metallographical and mineralogical studies of prehistoric and ancient artifacts (*12–13*), scientists have thus far played a very limited role in Chinese archeology.

Human Fossils—Paleolithic Sites

I have described human fossil remains discovered in China up to 1960 (*14*). In 1963 a human mandible was unearthed at Ch'en-chia-wo in Lan-t'ien, east-central Shensi (*15*), and in 1964 a human cranium was found nearby at Kung-wang-ling (*16*). The mandible occurred in a reddish clay stratum in association with elements of the Chou-k'ou-tien fauna, and the cranium was associated with a mixed Chou-k'ou-tien and Wan Hsien fauna of the Middle Pleistocene from deposits of Li-shih loess (*5*). Elements characteristic of south China Wan Hsien fauna indicate a warm climatic interval, and palynological data of grassy and broadleaf types of trees also suggest an interpluvial environment. Thus Lan-t'ien Man is regarded as largely contemporaneous with Peking Man. Its morphology is also pithecanthropoid, but the cranium (cover photo) shows more "primitive" features—a more pronounced supraorbital torus, a thicker wall, and a smaller cranial capacity (about 780 cubic centimeters). These fossils strengthen the view that there was a wide distribution of *Homo erectus* populations in the area of China during the Middle Pleistocene, but at the same time underline their internal diversity. Another significant feature of Lan-t'ien Man is the congenital absence of the third molar, a feature frequently evident among modern Eskimos, some American Indians, and many Asians (*17*).

Of the stone assemblages, the Choukoutienian and the Ordosian remain the leading industries of the Chinese Paleolithic, but the whole picture of the Old Stone Age has been amplified by new discoveries from identical or differing time periods (*18*). These include the Lower Paleolithic assemblages from Middle Pleistocene strata at K'o-ho, near Jui-ch'eng in southwestern Shansi, the Middle Paleolithic industry at Ting-ts'un from deposits dating from the Third Interglacial, and a large series of Upper Paleolithic sites in the Huangho Valley of north China and the Yangtze Valley of the southwest. These new findings indicate a fuller sequence of stone development from the archaic chopper-chopping tool complex to a sophisticated and mature blade industry as well as the regional diversification of Paleolithic cultures in China during each broad stage of this evolution. These trends of change and diversification have yet to be correlated with the evidence of human evolution and with microenvironmental research.

Dawn of Chinese Culture in North China

Recent archeological work in north China in connection with Neolithic cultures (*19*) has rendered obsolete the older ideas of Yang-shao and Lung-shan as two parallel cultures of different origins. Vastly increased amounts of data, stratigraphical evidence, and comparative studies of Neolithic assemblages of various types have jointly established the fact that Neolithic prehistory in north China marks the development of a single-culture tradition and that this development underwent at least the following broad stages (*20*).

1) *Incipient agriculture.* A largely hypothetical cultural interval marking the transition of northern Chinese prehistoric cultures from food gathering to food production.

2) *Establishment of the village farmers.* This is the stage of the Yang-shao Culture, largely confined to northwestern Honan, central Shensi, and southern Shansi—the so-called North China Nuclear Area.

3) *Expansion of the village farmers into the lowlands of eastern and southern China.* This stage is represented by a series of newly recognized cultures—Miao-ti-kou II, Ta-wen-k'ou, Ch'ing-lien-kang, Ch'ü-chia-ling, and Feng-pi-t'ou, collectively known as the Lungshanoid cultures.

4) *Formation of prehistoric local cultures.* This is the stage of the classical Lung-shan cultures, manifested in various local phases, in which emerged the cultures ancestral to the Shang and Chou civilizations.

Absolute dating of any of these stages of culture is impossible, but the entire sequence must have been completed by about 1850 B.C. when archeological evidence of the proto-Shang Culture becomes recognizable in the area. Thus the beginning of this developmental sequence can reasonably be placed at least several thousand years before the birth of Christ. How this sequence began is as yet unclear, but it must have been closely associated with the domestication of the foxtail millet (*Setaria italica*), the most important food plant in this cultural tradition. Botanical and paleobotanical studies are necessary to identify the region of this crucial event, which N. I. Vavilov (among others) considers to have taken place in the area of China (*21*), but the chronology of the archeological cultures seems to point to the Nuclear Area as the center of its earliest occurrence.

This Neolithic culture centering on the domestication and cultivation of foxtail millet is also the earliest identifiable manifestation of a Chinese culture. In contrast to other contemporary traditions, such as in the Near East and in Nuclear America, the Chinese tradition in Neolithic times is characterized by the following traits and complexes. A large variety of plants was cultivated and used for food or fabrics, or both. In addition to the foxtail millet, plants cultivated for food included the broomcorn millet (*Panicum miliaceum*), many vegetables of the genus *Brassica,* and possibly sorghum, and the soybean; those for fabric included at least one type of hemp. The fiber of plants was made into cordage and cloth, and basketry and matting were also highly developed. The silkworm (*Bombyx mori*) was raised for silk. Dog and pig were the most prominent domestic animals. Among the polished stone implements, most of which resemble comparable types seen elsewhere, the stone knife is distinctive—chipped or polished, rectangular or semilunar, with two side notches or one or more holes

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near the back. For harvesting of the millet ears, these knives were probably fastened to the hand with strings.

The pottery vessels were handmade, built up of coils; in later phases they were touched up on the wheel. In shape, surface treatment, and decoration, Chinese prehistoric pottery is highly distinctive. A base was frequently attached to the vessel, taking the form of a ring ("ring foot" or pedestal) or three solid or hollow feet (tripod). Pots for steaming food, including the so-called *tseng* and *yen* steamers, are highly characteristic and are evidence of the great antiquity of steamed foods in the Chinese cuisine. In addition to painting, paddle impression, which produced cord, mat, and basket patterns, was an important technique.

Houses in the Chinese Neolithic tradition were constructed with wattle-and-daub walls, floors plastered with a limey substance, and timber, on a basically rectangular plan, and probably with thatched and gabled roofs. Settlements typically followed a nucleated pattern, each divided into living quarters, pottery kilns, and cemetery, sometimes surrounded by walls constructed of layers of compressed earth. Finally, shoulder-blades of deer, pig, ox, and sheep were burned for the purposes of divination.

In the past, Western scholars often emphasized the similarities of the Chinese Neolithic and the Western Neolithic and speculated about a western origin. Recent studies have instead tended to stress the distinctive characters of the Chinese Neolithic tradition and the long history of its self-contained development. In synthesis, both recurrent themes of the ancient world and the salient features that are distinctively Chinese will undoubtedly prove equally significant.

Prehistoric Southeastern Stratigraphy

The very small number of prehistoric sites known in southeastern China before World War II indicated a culture characterized by black pottery similar to the Lung-shan in the north. A subsequent culture, identified with the Yüeh People in the history of the Chou Period (1122–221 B.C.) is known from its pottery impressed with geometric designs (the Geometric Pottery Culture). Recent archeological work from the Huaiho and the lower Yangtze to Fukien, Taiwan, and eastern Kwangtung drastically alters this simplistic picture and forms a fairly complete prehistoric stratigraphy from the first emergence of pottery through the end of the Chou period. This sequence is of particular interest for two reasons. Research indicates that southeast China was a part of the Southeast Asian hearth for another beginning of plant cultivation—one that paralleled if not preceded the Neolithic revolution in the north. Furthermore, the sequence is one of the best documented regional chronologies in Chinese prehistory and the only true beginning of cultural ecological explorations. Since my own work in Taiwan and Hong Kong during 1964–66 provides some easily available data, a short description follows (Fig. 2) (*11, 22*).

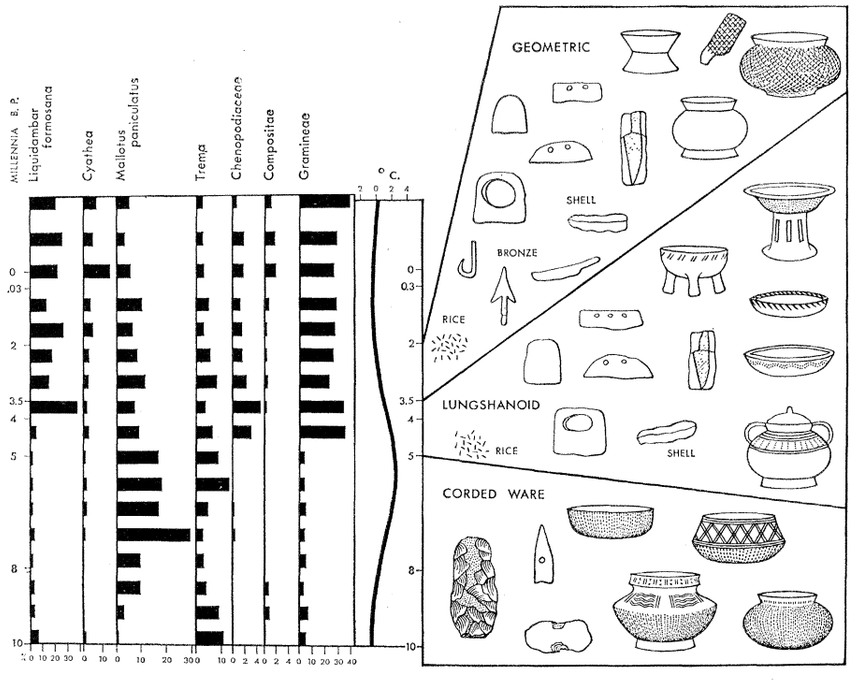

Fig. 2. Characteristic elements of major cultures in the prehistoric sequence of southeastern China (right) in relation to percentage changes of select plant species in the pollen profile of Jih-yüeh-t'an (left) and conjectured temperature curve (middle). [The pollen chart and temperature curve from (*4*).]

From Tsukada's pollen profile of the sediments of Jih-yüeh-t'an Lake in central Taiwan, it is evident that the postglacial period began about 10,000 years ago with a gradual but marked climatic amelioration after the severe cold maximum of the Tali Glacial. This warming trend had developed into a hypsithermal interval by about 8000 years ago. Seawater invaded coastal areas (*23*), and tropical vegetation characterized the lowlands. From deposits of this interval come the remains of a culture characterized by cord-marked pottery and implements of chipped and polished stone. The pots and bowls of coarse paste, impressed with marks of various kinds of cords and incised with short strokes and wavy lines, indicate the wide and sophisticated use of cordage and, by inference, of plant fibers. The implements, consisting of large and small adzes and stone sinkers, suggest the prevalence of woodcraft and fishing activities. Fish bones, mollusk shells, and bones of wild animals at many of the sites of this level demonstrate a pattern of subsistence based mainly on hunting, fishing, and mollusk collecting, but there was probably also a complex of activities involving an incipient cultivation of other plants for food and for other uses.

Ethnobotanists have long speculated that there was in the Asian tropics during the postglacial hypsithermal interval an ancient horticultural revolution involving groups of progressive waterside fishermen familiar with the local floral resources from which they gathered bark, fibers, and fish poisons and to which they contributed such cultigens as taro, yam, banana, and breadfruit (*24*). The archeological inventory of assemblages of cord-marked pottery in Taiwan and elsewhere in the southeast substantiates exactly such a cultural condition. In a pollen profile at Jih-

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yüeh-t'an, Tsukada recognizes a postglacial change of vegetational growth at about 10,000 years ago, when the numbers of secondary forest trees increased in the assemblage and the amount of charcoal fragments became markedly noticeable. He interprets this as suggesting some degree of forest clearance by men. The subsistence range of the cord-marked pottery culture remains to be clarified, but the excavations in Taiwan in this stratum were the first to localize a potential area of search for the long-sought site of the horticultural revolution. Significantly, the earliest Neolithic culture in the north is characterized by the same kind of pottery. It is now considered a distinct possibility that the earliest centers of plant cultivation in north China and in Southeast Asia—of which southeast China is a part—were closely related.

The next stratum of the southeastern prehistoric sequence includes two vastly dissimilar cultures—the Yüan-shan and the Lungshanoid—which emerged early in the third millennium B.C. The Yüan-shan Culture is geographically confined to the northern end of Taiwan; the term Lungshanoid designates a cluster of various cultures spreading from the Shantung peninsula to Taiwan and the eastern half of Kwangtung. At least three aspects of the Lungshanoid cultures are notably significant. (i) Their sites are uniformly characterized by the remains of rice. This is the earliest occurrence anywhere of cultivated *Oryza sativa*, and its remarkable importance in the native subsistence is well indicated by a marked increase of secondary trees, shrubs, weeds, and cereals in the vegetational history at Jih-yüeh-t'an, according to Tsukada's pollen profile there, about 4200 years ago, coinciding with the emergence of Lungshanoid cultures in that part of the area. (ii) The Lungshanoid cultures in the southeast and those in north China are so similar in the style of their artifacts as to indicate a common origin. (iii) There is demonstrable evidence of a substantial continuity from the prehistoric Lungshanoid cultures in Taiwan to the island's modern aboriginal cultures of Malayopolynesian-speakers. All of these go to show that the Lungshanoid horizon of southeastern China was a key to the explosive spread of cereal growers in Southeast Asia, and the relation between this event and the earlier cord-marked pottery cultures here is of crucial importance in the study of history of agriculture in the Far East (*25*).

The Lungshanoid horizon includes a number of local cultural phases; in Taiwan at least three such phases can be distinguished, more or less distinct in time and definitely distinct in region. After these there is a widespread cultural horizon on the mainland characterized by pottery impressed with geometric decorative patterns and, in many areas, bronze metallurgy or use of bronze objects. This geometric horizon has been well synchronized with the Shang and Chou civilizations of north China (*26*).

Rise of Shang and Chou Dynasties

During the last 20 years not only has additional information from An-yang become available but many other Shang sites have also become known. These amplify our knowledge of the first Chinese civilization and reveal an earlier stage that provides a link between the climactic An-yang phase and the antecedent Lung-shan Culture (*27*).

Among the new sites those in Yen-shih (western Honan) and Cheng-chou (northern Honan) are the most significant. Remains in Yen-shih are clearly indicative of a culture descended to the Honan Lung-shan Culture of the Neolithic period in terms of pottery and of stone, bone, and shell implements. What marks off the civilized Shang Culture from its barbarous antecedents are elements of an aristocratic complex that signifies the rise of a dynastic power, in contrast to the self-contained and more or less peaceful farming villages of the preceding Lung-shan period. Such elements at Yen-shih include stamped earth foundations of large, palatial houses, burials with sharply differentiated classes of grave

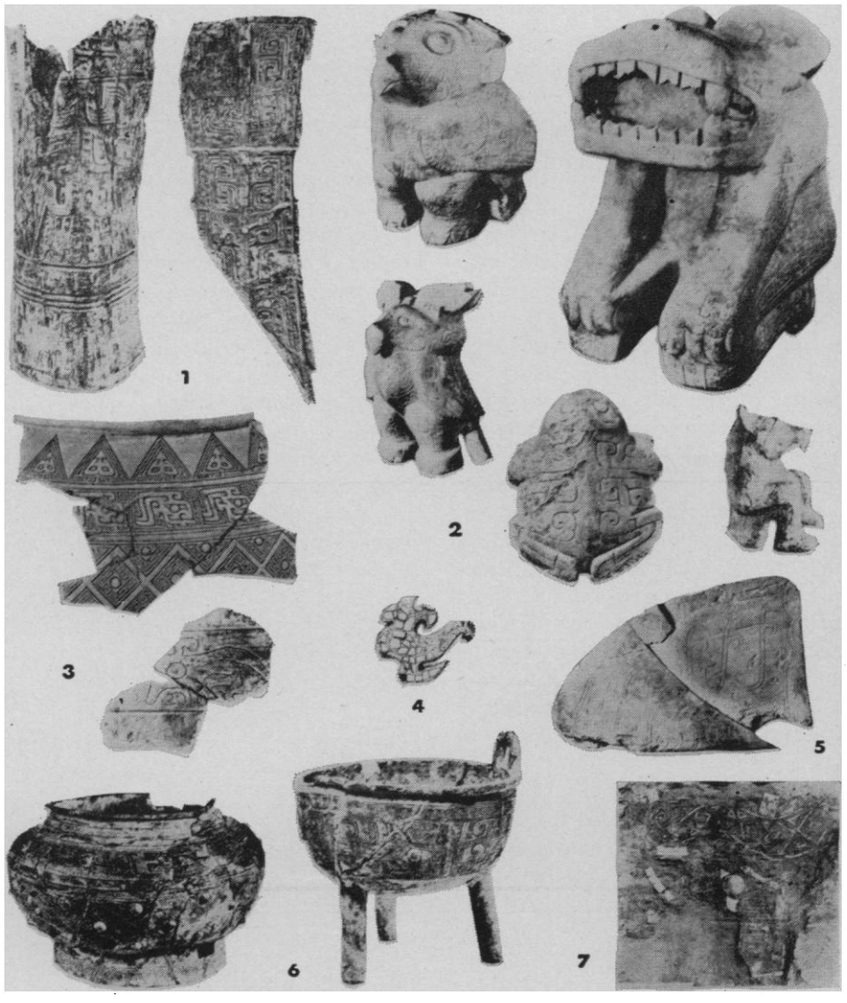

Fig. 3. Representative groups of Shang art from "Royal Tombs" 1001 and 1002 at An-yang. *1*, Bone carvings; *2*, stone sculptures; *3*, pottery; *4*, turquoise inlay; *5*, musical stone; *6*, bronze vessels; *7*, impression of wood-carving in clay. [From (*30*)]

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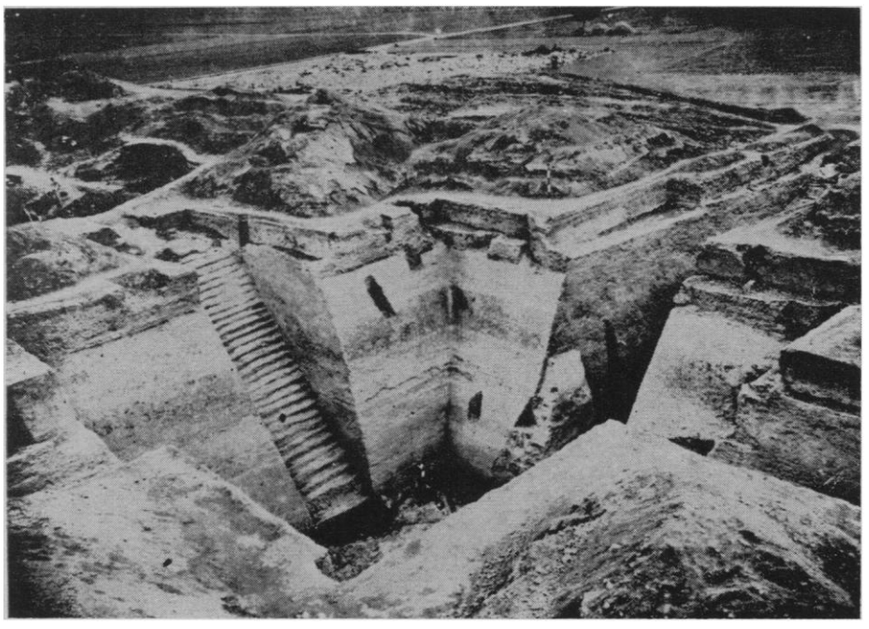

Fig. 4. Exposed grave pit of tomb 1002 at Hsi-pei-kang, An-yang. [From (*30*)]

furnishings, the appearance of pottery wine vessels indicating the existence of a leisurely social class preoccupied with ritual, and bronze objects and evidence of bronze metallurgy (*28*). At Cheng-chou, in addition to these, there are bronze vessels, a greater degree of handicraft specialization, remains of horse-drawn chariots, burials of human sacrificial victims, and a city wall of considerable magnitude. By the time An-yang had become the dynastic capital (about 1350 B.C.) the Shang had achieved a firm status among the giants of the civilized world, with writing and a great art style (Fig. 3). It was the civilization of a small group of aristocrats living in walled towns, vested with unparalleled military might derived from bronze weapons and the horse chariot, and possessing a sophisticated ritualistic art. The history of the development of this civilization from a humble beginning to its An-yang summit is well outlined by the new archeological data, although many details remain to be filled in.

Toward the end of the Shang period, while the Shang dominated the Huang-ho plains in the northern half of Honan, the Chou rose in the Wenshui Valley of central Shensi. Archeological discoveries in the Sian area (*29*), the site of the capitals of Kings Wen Wang and Wu Wang during the last part of the second millennium B.C., reveal a civilization parallel to that of the Shang, with bronze metallurgy and horse chariots. The well-known Chou conquest of the Shang, which took place in 1122 B.C., moved the Chou to the center of the ancient stage of north China to begin the Chou Dynasty that was to last, with diminishing influence, for the subsequent millennium.

The most significant of the various studies of the Shang and Chou civilizations made recently include the descriptions of the royal tombs in An-yang (Fig. 4) (*30*); the investigations of the oracle bone inscriptions for their illumination of Shang history, culture, and society (*31*); the exploration of the social institutions of the Shang and Chou peoples, derived from genealogical data (*32*); the investigation of bronze metallurgy and casting techniques (*33*); and the study of Shang art, especially the art of the ritual bronzes (*34*).

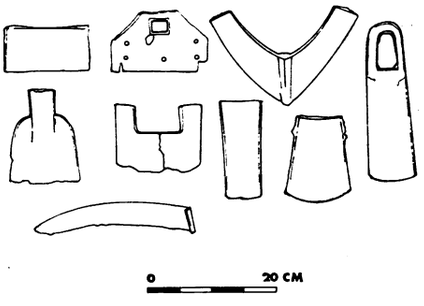

Fig. 5. Major types of iron implements of the Warring States period. [After (*19*), p. 61]

Development of Iron Tools

In the middle eastern Chou period—the 6th century B.C.—iron was widely used for agricultural implements in China, and a sophisticated iron metallurgy developed. This era coincides with the extensive rise of cities and local powers, large-scale irrigation, a commercial economy, and the geographic spread of the Chinese way of life.

Many cast-iron implements discovered before World War II in southern Manchuria and Korea were dated to the Warring States period (about 450 to 221 B.C.), and scholars believed that the same technique must have been developed earlier in north China. This has been confirmed by a metallographical study of four iron implements from the Warring States period excavated from Hopei, Jehol, and Hunan (*12*). The Chinese artisans probably produced cast iron at this early date because of their skill in the casting of intricate bronze objects and the firing of pottery at high temperatures. Perhaps the most significant fact about cast iron in ancient China is that both steel and wrought iron can be produced cheaply and in large quantity from cast iron through the so-called indirect process. The early development of this process evidently took place almost exclusively within the borders of China, where the history of iron metallurgy followed a radically different course from that of the countries to the west (*35*). One result of this is that mass-produced iron became the metal of the Chinese peasantry and found an early extensive use in the making of agricultural implements.

Iron implements began to be found in large numbers in sites and tombs of the Warring States period (*36*). The common types include axes, adzes, chisels, spades, sickles, hoes, and plow blades (Fig. 5). The earliest iron plows that are well documented archeologically come from the Warring States tombs at Ku-wei-ts'un in Hui Hsien, northern Honan (*37*). These are flat, V-shaped iron pieces which probably were mounted on wooden blades to serve as working edges. These are relatively small pieces (18 centimeters wide) and could not have been very efficient. There is no archeological evidence of the wide use of cattle for plowing, but there is no question that with the advent of new iron tools drastic changes must have taken place in the cultivation of farming fields. One of the direct manifestations

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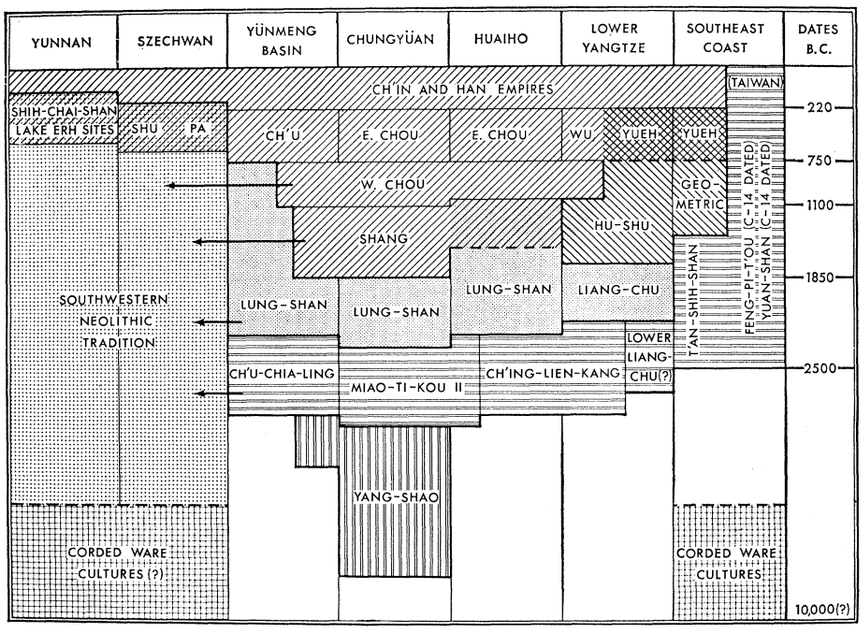

Fig. 6. Prehistoric and early historic culture chronologies in South China in relation to the control sequence in the Central Plain of North China. [From (*2*), p. 445]

of the efficient use of iron implements in farming is the unmistakable evidence of large-scale systems of irrigation ditches in a number of states.

Indirectly, the more efficient use of iron implements for agriculture and industry is strongly suggested by the much greater material wealth evident in archeological remains of the Warring States period throughout much of China. Vast numbers of walled towns were constructed in all the Warring States, and many of the towns were enlarged to incorporate workshops of all sorts, mints, and market places, as well as dwelling houses, palaces, and temples. Iron weapons are widely thought to have changed the patterns of warfare and eventually facilitated the unification of China under the Ch'in Empire.

Local Cultures at Ch'in Unification

The ethnocentric self-image of traditional Chinese historiography (*38*), similar to that of any other historiographic tradition, is well known, and the focus of prehistoric and early historic attention in China had been the development of the civilization that was to be Chinese. Cultural assemblages found throughout the country and embracing a diversity of styles and derivations show that prehistoric and early historic China was a land of many diverse and interacting cultures and that the Chinese tradition, in spite of its dominant position and its vast influence, was essentially one of many independent cultures of the Far East.

Archeologically, it is possible to discern at least three different regional cultural traditions at the first appearance of pottery: those of northern China, described above; cultures of the northern borders of the country characterized by microlithic implements and brownish, coarse, and incised and dentated pottery; and those in southwest China and the southernmost coastal areas, characterized by cord-marked pottery. The first and the last of these cultures probably took the initiative in the cultivation of plants for food and for fiber. Subsequent prehistory of the area may be characterized simply as the continuous developments of the northern and the southwestern traditions, the phenomenal growth and spread of the northern Chinese tradition, the localization of the northern Chinese tradition in new areas of distribution, and the interaction of the three major cultures and of the many minor traditions within them.

The first major spread of the northern Chinese tradition is marked in the archeological record by the Lungshanoid horizon that extends from the heart of north China to the entire eastern and southeastern coast. In various places different regional phases or cultures formed, such as the Miao-ti-kou II of Honan, the Ta-wen-k'ou of Shantung, the Ch'ü-chia-ling of Hupei, the Ch'ing-lien-kang of Kiangsu, the Early Liang-chu of Chekiang, the T'an-shih-shan of Fukien, and the Feng-pi-t'ou of Taiwan. These local Lungshanoid cultures probably resulted from a combination of migration from the Nuclear Area of north China and cultural contact with the southwestern Neolithic tradition (*39*). They were apparently ancestral to such subsequent Lung-shan cultures as those of Shensi, Honan, Shantung, and Liang-chu. By the time the Shang and Chou cultures had emerged, much of China was occupied by village farmers of a great diversity of local cultural traditions, which, in turn, were probably ancestral to most of the local "barbarous" ethnic groups recorded in the written literatures of the Shang and the Chou dynasties.

In the middle of the Chou period, many of the local barbarous cultures throughout China acquired technological and other advances and achieved civilized status. Many local civilizations of the late Eastern Chou period are recognizable from archeological data. In the north there are the stone-cist people of southern Manchuria, the Ordos bronze artisans of southwestern Inner Mongolia, and the Kansu cultures with their painted pottery and copper and bronze artifacts. In the south, a vast amount of remains has come to light to illustrate the high cultures of the Yüeh of the lower Yangtze and the southeastern coast, the Ch'u of the central Yangtze, the Pa and the Shu in the Red basin of Szechwan, and the Tien of Yunnan. Although the Ch'in unification brought these various local cultures under a solitary government and economy, various ethnic identities remained in China throughout much of Chinese history to provide background for the various regional subtraditions of the Chinese civilization (Fig. 6).

References and Notes

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an up-to-date and relatively full account of the subject, together with a detailed bibliography. I refer to this book for detailed documentation for this article in which only the most important and representative references will be cited.
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39. J. Treistman [*Science* **160**, 853–56 (1968)], in an attempt to show that "China, at 1000 B.C., was an area of great diversity," tries to refute the whole Lungshanoid concept. She believes that the "so-called prehistoric Lungshanoid is conceived in terms of dynastic succession and expansion as it spreads its enlightening influence throughout China." By using this North China–derived concept to "cover prehistoric and early historic phenomena occurring outside of the nuclear area," my interpretation of this part at least of Chinese prehistory is thus "a reversion to the technique of writing colonial history." That China, at 1000 B.C., or any other time, was a land of diversity is not open to question, but diverse local cultures are subject to classificatory groupings at various levels of contrast for different interpretive objectives. What Dr. Treistman has apparently failed to grasp is that "Lungshanoid" is merely a classificatory label at a high level of contrast, and that under this label cultural regionalization is not only possible but inevitable. Furthermore, the label "Lungshanoid" is descriptive, or even interpretive, but not evaluative. To say that the Lungshanoid *influenced* some culture is not to say that it "enlightened" it. I wish Dr. Treistman had documented her statement that I conceived of the Lungshanoid concept "in terms of *dynastic* succession and expansion as it spreads its *enlightening* influence throughout China" (Italics mine). Migrations, expansions, and mutual influences of prehistoric cultures and peoples took place —or are thought by archeologists as having taken place—throughout human existence all over the world, and I do not see anything peculiar about their having taken place in and around China. The Lungshanoid interpretation simply represents my current view of what took place, according to the available evidence, expressed in a classificatory taxonomy.

Fluorescence Spectroscopy of Proteins

Fluorescent probes provide insight into the structure, interactions, and dynamics of proteins.

Lubert Stryer

Proteins are directly involved in all known biological processes except for the storage of genetic information. The diversity of functions carried out by proteins is matched by the variety of their three-dimensional structures. A challenging area of inquiry in molecular biology is the relation between protein structure and function. In particular, protein chemists are trying to answer three basic questions with respect to the relation between structure and function: (i) How do proteins fold? That is, how does the simple linear array of 20 kinds of amino acids specify the complex three-dimensional structure crucial for the function of the protein? (ii) How do proteins recognize other molecules? What is the basis of the high degree of selectivity displayed by proteins in their interactions with large and small molecules? (iii) How do proteins carry out particular functions, such as catalysis, transport, and motility?

Detailed structural and kinetic data on proteins and their interactions are needed to answer these questions. X-ray crystallography, one of the most powerful experimental approaches, has revealed the structure of five proteins, thereby contributing toward a deeper understanding of how they function. However, the x-ray crystallographic method is not sufficient in itself. The view it affords, although magnificently detailed, is essentially static. Furthermore, not all interesting biological materials can be crystallized. Clearly, no single experimental approach can encompass the richness and complexity inherent in problems of protein structure and function. A number of quite different physical and chemical techniques must be applied and their results correlated.

I shall now discuss some aspects of fluorescence spectroscopy as used to gain insight into the structure and dy-

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